REMOTE DYNAMICALLY RECONFIGURABLE NETWORK PROCESSING MIDDLEBOX

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Specially dedicated to my beloved family, lectures and friends
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ABSTRACT

Remote dynamically reconfigurable platforms use dynamic reconfiguration to provide solutions for applications to cope with changes in both functional and performance requirements. Most existing remote dynamically reconfigurable platforms are inefficient in handling dynamic reconfiguration process. This is due to the use of general-purpose processor in their designs or having limited partial bitstream transmission throughput that results in long device down-time. This thesis presents an architecture of remote dynamically reconfigurable middlebox on NetFPGA development board. The developed platform relies on a customized reconfiguration controller and Internal Configuration Access Port to achieve dynamic reconfiguration. In addition, this platform uses 1Gbps Ethernet link for partial bitstreams transmission to achieve remote update. In order to offer maximum flexibility for network processing, this work includes an architecture that allows remote updates on packet-forwarding as well. This allows packet-forwarding algorithm and its implementation to be optimized or customized after deployment. A case study on network protection using this platform is included in this thesis to verify application functionality updates. All hardware designs are verified using ModelSim simulation and tested experimentally using the NetFPGA development board. The developed remote dynamically reconfigurable platform is stand-alone and can achieve remote functional update without the need of a host computer. Based on experimental results, the proposed platform achieves 350Mbps reconfiguration throughput, which is significant for mass remote update as device downtime for update is reduced. The developed platform is suitable to be used as network processing middlebox.

ABSTRAK

Platform keboleh-tatarajahan semula dinamik secara jarak jauh menggunakan fitur tatarajah semula dinamik untuk menyediakan penyelesaian kepada aplikasi dalam menangani perubahan keperluan fungsian dan prestasi. Kebanyakan platform keboleh-tatarajahan semula dinamik secara jarak jauh sedia ada adalah tidak efisien dalam pengendalian proses pentatarajahan semula. Hal ini disebabkan penggunaan pemproses tujuan am di dalam reka bentuk atau mempunyai kadar celus yang sangat terhad dalam penghantaran aliran bit separa yang boleh mengakibatkan masa henti peranti yang panjang. Tesis ini membentangkan seni bina *middlebox* keboleh-tatarajahan semula dinamik secara jarak jauh dengan menggunakan papan pembangunan NetFPGA. Platform yang telah dibangunkan bergantung kepada pengawal pentatarajahan semula tersuai dan port capaian tatarajah semula dalaman untuk mencapai pentatarajahan semula secara dinamik. Di samping itu, platform ini menggunakan pautan Ethernet selaju 1Gbps dalam penghantaran aliran bit separa untuk melaksanakan kemas kini secara jarak jauh. Dalam usaha untuk menawarkan kelenturan maksimum untuk pemprosesan rangkaian, kerja ini juga merangkumi satu seni bina yang membolehkan kemas kini jarak jauh pada algoritma ajuan paket. Hal ini membolehkan algoritma ajuan paket dan implementasinya dioptimumkan atau disesuaikan selepas kerah tugas. Satu kajian kes dalam perlindungan rangkaian dengan menggunakan platform ini terkandung dalam tesis ini untuk menentusahkan kemas kini fungsian aplikasi. Semua reka bentuk perkakasan telah ditentusahkan dengan menggunakan simulasi ModelSim dan diuji secara eksperimen dengan menggunakan papan pembangunan NetFPGA. Platform keboleh-tatarajahan semula dinamik secara jarak jauh yang telah dibangunkan boleh berfungsi secara kendiri dan dapat mencapai kemas kini fungsian secara jarak jauh tanpa memerlukan komputer hos. Berdasarkan keputusan eksperimen, platform yang dicadangkan dapat mencapai kadar celus pentatarajahan semula sebanyak 350Mbps, yakni penting kepada kemas kini jarak jauh secara besar-besaran kerana masa henti peranti semasa kemas kini telah disingkatkan. Platform yang telah dibangunkan sesuai diguna sebagai peranti perantaraan dalam pemprosesan rangkaian.